REPTILE DIVERSITY AT RISK IN THE BRIGALOW BELT, QUEENSLAND

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Much of the extensive Brigalow Belt (BB) of Queensland has been cleared, primarily for grazing and agriculture. As a result, the conservation status of the region's natural ecosystems is poor: 65 of 163 ecosystems of the region are classed 'endangered' or 'of concern'.

Reptile diversity and species endemism in the region are high, but many species appear to be 'at risk', presumably from clearing. One hundred and forty-eight species of reptiles occur in the BB; 13 of these are confined or virtually confined to the region; and, for a further 14 species, the BB is a significant portion of their ranges in Queensland. Type localities of 49 nominate reptile species are in the BB of Queensland. (These, vital in species delineation and attempts to maintain diversity, have been overlooked in management). At only 10 of 28 discrete type localities for reptiles in the region are there still good stands of native vegetation in which a full complement of reptile species might flourish.

Under IUCN Species Survival Commission definitions, one species (*Lerista allanae*) is critically endangered; one (*Anomalopus mackayi*) is endangered; eleven (*Rheodytes leukops, L. vittata, Diplodactylus taenicauda, Delma labialis, Paradelma orientalis, Anomalopus brevicollis, A. leuckartii, Denisonia maculata, Furina barnardi, F. dunmalli* and *Hemiaspis damelii*) are vulnerable; one (*Acanthophis antarcticus*) is of lower risk; and four (*Delma plebeia, Egernia rugosa, Lerista cinerea, Menetia sadlieri*) are data deficient. Further, five species appear to be at risk on a local, BB scale: *Chlamydosaurus kingii, Tympanocryptis lineata, T. pinguicolla, Tiliqua rugosa* and *Aspidites ramsayi.*

The BB is an example of how a region should not be managed to maintain biodiversity. Extensive clearing of native forests, overgrazing, intensification of agriculture and proposed significant water infrastructure for further development raise serious concern about maintenance of biodiversity in this region, unless integrated nature conservation strategies are enacted urgently. □ *Brigalow Belt, reptiles, biodiversity, conservation, Queensland.*

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'... Clearing of brigalow lands for crops and pasture has reaped great economic benefits but it has also had severe negative impact on native ecosystems ... flora and fauna ...' Johnson (1996).

The Brigalow Belt (the Northern and Southern Brigalow Regions) encompasses about 20% of Queensland, roughly between the 500 and 750mm isohyets, in tropical (south of Townsville) and subtropical Queensland (Fig. 1) and northern New South Wales (Stanton & Morgan, 1977; Thackway & Cresswell, 1995).

Prior to European settlement, the Brigalow Belt (BB) was a complex mosaic of woodlands (e.g., dominated by *Eucalyptus crebra* and *E. drepanophylla; E. populnea* and *E. brownii; E. melanophloia; E. coolabah, E. tereticornis* and *E. tessellaris*); forests (e.g., of *E. tereticornis* and *E. camaldulensis*); shrubby open forests (e.g., dominated by *Acacia harpophylla*, sometimes mixed with *E. cambageana, Cadellia pentasyeis, A. cambagei, A. shirleyi* or *A. rhodoxylon*; diverse semideciduous vine thickets; and open grasslands (e.g., of *Dichanthium serviceum*).

The BB supports a highly diverse vegetation, classified in 163 regional ecosystems of 36 vegetation provinces (P. Sattler, pers. comm.). However, because of long European settlement (Nix, 1994) and concomitant large-scale clearing of native vegetation for grazing, farming and mining, representation of its habitat diversity, particularly on fertile soils, in conservation reserves is poor.

Some conservation reserves (national parks, conservation parks and resource reserves) have been set aside for the protection of plant/animal diversity of the region as well as spectacular scenic features like Carnarvon Gorge. These reserves range in size from less than 2ha to nearly 300,000ha and account for 2.07% of the BB, most of which is associated with rugged sandstone areas. Other native forests are partly protected in

State Forests (2,622,239ha) and Timber Reserves (140,472ha). Many BB habitats are now at risk and are of concern to land managers, wildlife/diversity managers and conservationists. The numbers of regional ecosystems classified as endangered (32) and of concern (33) (P. Sattler, pers. comm.) highlights the difficulty confronting attempts to maintain the region's biodiversity. *A. harophylla* communities, semideciduous vine thickets and native grasslands, particularly, have been extensively modified and are now extremely poorly protected in reserves, largely because they occur/occurred on the richer soils. This problem has been highlighted many times (e.g., Sattler & Webster, 1984; Gasteen, 1985, 1987; Sattler, 1986, 1993; Davie et al., 1994; and Johnson, 1996).

In a context of widespread replacement of native vegetation of the BB with crops, introduced pastures and accompanying plant and animal pests, it is not surprising that the native vertebrates, especially species restricted to the region, would be in decline. Extinct bird and mammal species once occurring solely or mainly in the BB include: *Psephotus pulcherrimus, Notomys mordax* and *Conilurus albipes*; species extinct from the BB but still extant beyond this region include *Pseudomys australis* and *Macrotis lagotis*; species whose populations have declined significantly and are now threatened include *Neochina ruficauda ruficauda, Erythrotriorchis radiatus, Lasiorhinus krefftii* and *Onychogalea fraenata* (Gordon, 1984; Garnett, 1992; Lee, 1995 and Maxwell et al., 1996).

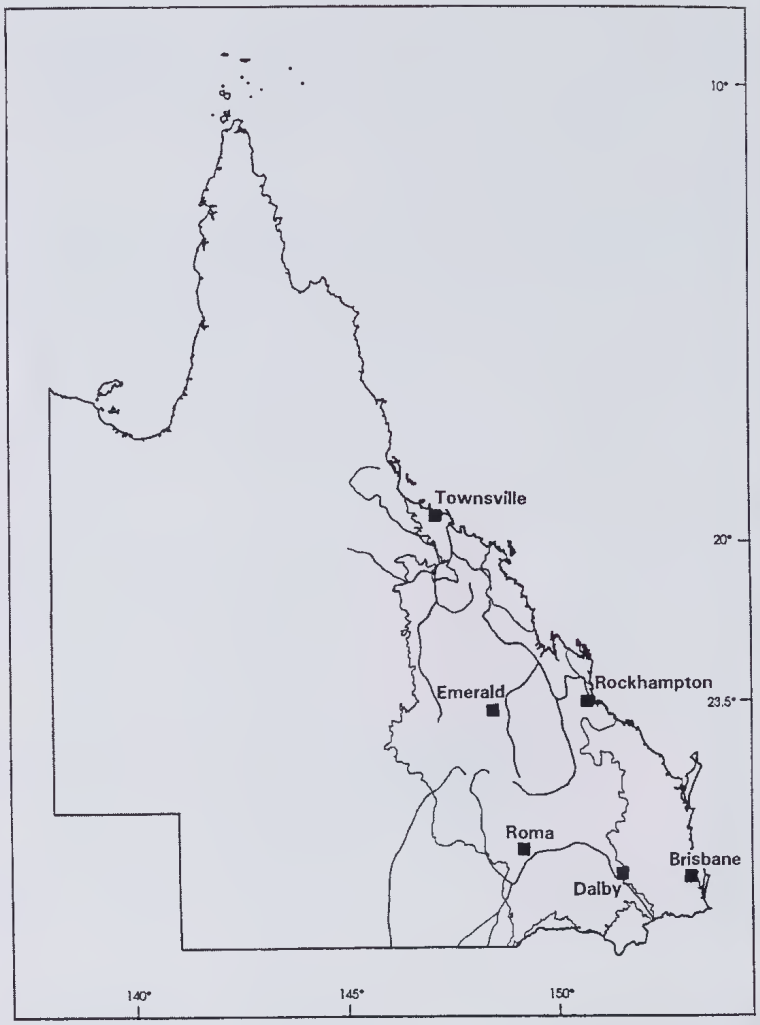

FIG. 1. Main towns/cities and river systems of Queensland's Brigalow Belt.

Reptiles of the BB have received little attention until recently (e.g., Gordon, 1984; Covacevich et al., 1988; Czechura & Covacevich, 1985; Cogger et al., 1993; McDonald et al., 1991). Significant collections of reptile specimens from the region have been deposited in museums (notably the Queensland and Australian Museums [Brisbane, Sydney, Australia] and the California Academy of Sciences in San Francisco, USA). Some general surveys of areas in the BB have included reptiles (e.g., Kirkpatrick, 1968; James, 1974; Crossman & Reimer, 1986; Russell et al., 1992; and Horsup et al., 1993) and the conservation status of some reptile species from the area has been assessed (Gordon, 1984; Covacevich et al., 1988; Czechura & Covacevich, 1985; McDonald et al., 1991; Cogger et al., 1993; Covacevich & Couper, 1996; and Covacevich et al., 1996a) but no methodical review of the distributions of all BB reptile species and their conservation status has been pubished.

In 1994, financial support to review museum and literature records and conduct field work to refine knowledge of the distribution and conservation status of rare or threatened BB reptile

species was received from the Australian Nature Conservation Agency (now Environment Australia). *Lerista allanae* (Longman, 1937), a species believed to be very rare, received special attention. All specimen records in the Australian Museum, the Queensland Museum and the California Academy of Sciences and all relevant records in the few BB surveys which have included reptiles were examined. Field work was undertaken in 1995 and 1996, in areas selected in an attempt to add to or clarify existing records: Emerald-Capella-Clermont district, central BB, 13-24 February, 1995 (JAC, PJC); Inglewood-Tara-Yuleba district, southern BB, 13-27 March, 1995 (JAC, PJC); Emerald-Clermont-Collinsville district, central and northern BB, 20-29 April, 1995 (JAC, PJC, KRMcD); Capella district, central BB, 9-16 February, 1996 (PJC, JAC). In all areas, standard hand-collecting, spot-lighting, and pit-trapping methods were employed. Pit-trapping has been shown to be a valuable sampling method for small species (e.g., Hannah & Smith, 1995; Hobbs et al., 1994). Voucher specimens from the field work have been added to the Queensland Museum reference collection. They bear registration numbers QMJ59368-424, QMJ59516-576, QMJ59781-870, QMJ61407-423 and QMJ61426-461.

Major findings (published) of this study are: maintenance of reptile diversity in the BB appears to be unlikely in the face of further clearing of native vegetation (Covacevich, 1996); *Lerista allanae* is at least critically endangered and may be extinct (Covacevich et al., 1996a); *Aspidites ramsayi* (Macleay, 1882) is vulnerable in the southern portion of the BB (Covacevich & Couper, 1996); and, despite extensive clearing in the Emerald district, a highly diverse array of small reptiles survives in a disturbed *Callitris* forest close to Emerald (Deer, 1996). Further, incidental observations made during the study have enhanced knowledge of *Nephrurus asper, Gehyra dubia* and *Vermicella annulata* (Couper, 1996; Couper et al., 1995; and Couper et al., 1996) and of the previously unknown donor of the holotype of *Lerista allanae*, Maida Allan (Covacevich & Couper, 1997).

REPTILE DIVERSITY OF QUEENSLAND'S BRIGALOW BELT

One hundred and forty-eight species of reptiles are known from Queensland's BB (Appendix 1). The occurrence of these species has been mapped from collection/sight localities which have been listed in an unpublished report lodged with Environment Australia (Canberra) and in the Library, Queensland Museum (Brisbane), accession number 97/22378, Covacevich et al., 1996b.

The ranges of 13 species are confined to, or virtually confined to the BB: *Rheodytes leukops* Legler & Cann, 1980; *Diplodactylus taenicauda* De Vis, 1886 (Fig. 2); *Paradelma orientalis* (Günther, 1876); *Anomalopus brevicollis* Greer & Cogger, 1985; *Anomalopus mackayi* Greer & Cogger, 1985; *Ctenotus ingrami* Czechura & Wombey, 1982; *Lampropholis mirabilis* Ingram & Rawlinson, 1981; *Lerista allanae* (Longman, 1937); *Lerista vittata* Greer, McDonald & Lawrie, 1983; *Menetia sadlieri* Greer, 1991; *Denisonia maculata* (Steindachner, 1867); *Furina dunmalli* (Worrell, 1955); *Hemiaspis damelii* (Günther, 1876). For a further 14 species, the BB is a significant part of their ranges in Queensland: *Chelodina expansa* Gray, 1867; *Gehyra catenata* Low, 1979; *Oedura monilis* De Vis, 1888; *Saltuarius salebrosus* (Covacevich, 1975); *Anomalopus leuckartii* (Weinland, 1862); *Egernia modesta* Storr, 1968; *E. rugosa* De Vis, 1888; *Eulamprus sokosoma* Greer, 1992; *Glaphyromorphus punctulatus* (Peters, 1871); *Lerista fragilis* (Günther, 1876); *Menetia timlowi* Ingram, 1977; *Hoplocephalus bitorquatus* (Jan, 1859); *Pseudechis guttatus* De Vis, 1905; and *Suta dwyeri* (Worrell, 1956) =*S. spectabilis dwyeri* (Worrell, 1956).

CONSERVATION STATUS

Given that much of the BB has been cleared, that 40% of its regional ecosystems are classed endangered or of concern, that several bird and mammal species formerly from the area are extinct and that populations of many bird and mammal species of the region have declined seriously, it is predictable that reptile species of the BB would be at risk. Species confined to or occurring predominantly in the region are of most concern. Prior to this study, three authorities had afforded special conservation status to reptile species from the BB in Queensland (McDonald et al., 1991; Cogger et al., 1993; Queensland Nature Conservation (Wildlife) Regulation 1994). Table 1 summarises the status of rare and threatened species of reptiles of this region according to these authors.

In November, 1994, the 40th meeting of the IUCN Council of the IUCN Species Survival Commission prepared '... new definitions for Red List categories ...' of threatened species. In the light of these, following our field work and review of reptile specimen records in museums and relevant literature, the current conservation status of

FIG. 2. One of 15 reptile species currently at risk in Queensland's Brigalow Belt. *Diplodactylus taenicauda* is vulnerable. Specimen collected (and released) near Yulcba, SCQ, 21 March, 1995, during extensive reptile surveys in the region. (J. Wright, Queensland Museum)

species of special concern at the national/international level can be assessed. Under the IUCN (1994) definitions one species is critically endangered; one is endangered; 10 are vulnerable; two are at lower risk, near threatened; and four are data deficient (Table 2).

Under the IUCN definitions, one BB reptile species previously classed rare or threatened (McDonald et al., 1991; Cogger et al., 1993; Nature Conservation (Wildlife) Regulation, 1994) does not qualify for special conservation status. *Chelodina expansa* of rivers and lagoons in and beyond the BB is apparently not presently at risk. Another species (*Lampropholis mirabilis*), formerly classed rare and threatened (McDonald et al., 1991; Cogger et al., 1993; Nature Conservation (Wildlife) Regulation, 1994) warrants discussion. *L. mirabilis* clearly is a vulnerable (VU D2) species: '... population very small or restricted ... acute restriction in its area of occupancy ... thus prone to the effects of human activities (or stochastic events) ...'. This species is known from only three localities (Magnetic I., Cape Cleveland and Mt Elliot, all near Townsville, NEQ, in the north-east part of the BB over an area considerably smaller than 100km^2. The full known range of this species is secure in national parks. Thus, given that this species is not prone to any identifiable threats, we do not regard it as being vulnerable.

A further 5 reptile species appear to be at risk in the BB: *Chlamydosaurus kingii* Gray, 1825 is primarily a species of northern and coastal Queensland. Two museum specimens (QMJ15592 - 97km E of Clermont, 22°48'S 148°31'E; QMJ33566 - Coorara stockroute, ca 55km ENE of Emerald, 23°05'S 148°25'E) attest to the occurrence of this species in the BB. These were registered in 1968 and 1990 respectively. Reliable, more recent sight records have been made in the BB: 20 Feb., 1992, Epping Forest 22°19'S 146°45'E, (G. Porter, Department of Environment, pers. comm.); 13 Feb., 1995 Taunton, 23°30'S 149°15'E (G. Porter, pers. comm.); Feb. and Oct., 1991 Wonga Hills, 26°06'S 150°45'E (Russell et al., 1992). *C. kingii* is a species well-known and frequently-reported elsewhere. Records of this species in the BB appear both to be and to have been scant, and most of the few localities from which it is known have been modified for farming or grazing. Epping Forest and Taunton, where specimens of *C. kingii* were seen in 1992 and 1995, are small national parks. This affords some hope for the survival of this species in the BB.

Tympanocryptis lineata Peters, 1863 was classed by Gordon (1984) in the first review of fauna (=mammals, primarily) of the BB as 'a lizard of the blue grass downs of central Queensland'. 'Natural grasslands, downs...' he noted '... were greatly favoured by early settlers and have been subject to heavy grazing since first settlement...'. Since these surveys of the 1970s and the Gordon (1984) review, much of the area near Emerald where *T. lineata* occurred has been developed for agriculture. Museum specimens of *T. lineata* have not been collected recently: 2 April, 1976, Emerald Downs 23°29'S 148°08'E (QMJ36851); 4 Jan., 1976, Selma 23°31'S 148°02'E (QMJ36849); 5 Oct., 1976, 22 Sept., 1976, 5 Oct., 1976, Iona 23°32'S 147°57'E (QMJ36853, QMJ36848, QMJ36852); Nov., 1977, nr Emerald 23°32'S 148°15'E (QMJ36847);10, 19, 22 Aug., 1929, 9 Sept., 1929 Retro 20m W of Capella 22°52'S 147°54'E (Cal. Acad. 77623-77626).

TABLE 1. Rare and threatened species of reptiles from Queensland's BB according to three recent authorities.

Species	Authority		
	McDonald et al., 1991	Cogger et al., 1993	Nature Conservation (Wildlife) Regulation 1994
Chelodina expansa	—	rare or insufficiently known	—
Emydura macquarii	—	rare or insufficiently known	—
Rheodytes leukops	very restricted, poorly known	vulnerable	vulnerable
Diplodactylus taenicauda	—	rare or insufficiently known	rare
Delma labialis	very restricted, rare	vulnerable	vulnerable
Paradelma orientalis	restricted to specific habitats, vulnerable	vulnerable	vulnerable
Anomalopus brevicollis	restricted to specific habitats, poorly known, occurring in reserves	—	rare
Anomalopus mackayi	restricted to specific habitats, poorly known	vulnerable	vulnerable
Ctenotus eutaenius	restricted to specific habitats, poorly known, occurring in reserves	—	—
Egernia rugosa	restricted to specific habitats, rare	rare or insufficiently known	vulnerable
Lampropholis mirabilis	very restricted, rare, occurring in reserves	rare or insufficiently known	rare
Lerista allanae	restricted to specific habitats, rare	endangered	endangered
Lerista cinerea	very restricted, poorly known	rare or insufficiently known	rare
Lerista vittata	very restricted, poorly known	vulnerable	vulnerable
Menetia sadlieri	—	rare or insufficiently known	rare
Acanthophis antarcticus	—	rare or insufficiently known	rare
Denisonia maculata	restricted to specific habitats, vulnerable, occurring in reserves	vulnerable	vulnerable
Furina barnardi	—	rare or insufficiently known	rare
Furina dunmalli	restricted to specific habitats, vulnerable, occurring in reserves	vulnerable	vulnerable

T. pinguicolla Mitchell, 1948 was described as a subspecies of *T. lineata*. Concern about prospects for survival of '*T. lineata pinguicolla*' has been expressed recently because of 'substantial loss and modification of native grasslands in south-eastern Australia' (Osborne et al., 1993). Current taxonomic review of *Tympanocryptis* spp. indicates that *T. pinguicolla* is a distinct species (A. Greer, pers. comm., Nov., 1997). In southern Queensland, *T. pinguicolla* appears to have an extremely restricted range. It has been recorded only near the southeastern boundary of the BB, in the Oakey district. Museum holdings of this species are scant and not recent: no date, Bougeen near Oakey 27°34'S 151°27'E (QMJ8604); Dec., 1978, 30km S of Oakey 27°39'S 151°36'E (QMJ34744). There have been no recent reports of sightings of *T. pinguicolla* in the southern BB, despite considerable field work in and near appropriate localities. The case of *T. pinguicolla* at the north-eastern limit of its range in the BB of Queensland parallels a major conservation problem highlighted by Daugherty et al., 1990 for *Sphenodon* spp. In reviewing the conservation/management of these species, they showed how a lack of awareness of species/'taxonomic neglect' could lead to extinction.

Tiliqua rugosa (Gray, 1825) is a large, conspicuous skink. Many museum specimens of this species, frequently obtained as 'road-kills', are held from the BB (e.g., Ingram & Raven, 1991). This is an easily-identified species reported often. In Queensland it has been recorded subtropically and subcoastally in the BB and mulga lands immediately to the west of the BB. The last BB specimen added to the Queensland Museum collections is QMJ58785 (Mungallala 26°27'S 147°33'E, Dec., 1993). No specimens were seen during our field work in the BB. This included intensive work on Retro Station and the lands which were formerly part of this station, a known former locality of *T. rugosa* (Cal. Acad. 76652-76653, 8, 14 August, 1929). Retro has been cleared almost entirely of native vegetation. Whether *T. rugosa* populations have declined in recent years has not been shown conclusively. However, probable local declines have been suggested also by other herpetologists who have worked in the BB (S. Irwin and C. Eddie, pers. comms).

Aspidites ramsayi (Macleay, 1882) has recently been shown to be vulnerable in the southern BB (Covacevich & Couper, 1996).

TABLE 2. Conservation status of reptile species at risk in the BB of Queensland, under IUCN Species Survival Commission definitions of 1994.

Species	Conservation Status		
Lerista allanae	'critically endangered'	'(CE) C2a'	'Population estimated to number less than 250 individuals ... A continuing decline...'
Anomalopus mackayi	'endangered'	'(EN) A1c'	'Population reduction ... of over 50% over the last 10 years ... based on ... decline in quality of habitat...'
Rheodytes leukops *Lerista vittata*	'vulnerable'	'(VU) D2'	'Population restricted ... characterised ... by an acute restriction in its area (typically less than 100km2) ... the number of locations (typically less than 5)...'
Paradelma orientalis *Diplodactylus taenicauda* *Anomalopus brevicollis* *Anomalopus leuckartii* *Denisonia maculata* *Furina barnardi* *Furina dunmalli* *Hemiaspis damelii*	'vulnerable'	'(VU) A1c'	'Population reduction ... decline in area of extent of occurrence and ... quality of habitat ...'
Acanthophis antarcticus *Delma labialis*	'lower risk, near threatened'	'(LR) 2nt'	'... close to qualifying for vulnerable ..'
Delma plebeia *Egernia rugosa* *Lerista cinerea* *Menetia sadlieri*	'data deficient'		'inadequate information ... appropriate data on abundance and/or distribution is lacking ... possibility that future research will show ... threatened ... is appropriate'

Our field work and a study arising from it (Deer, 1996) have shown that reptile diversity can remain high in protected reserves and state lands of the BB (e.g., Dipperu N.P./16 species; Yuleba SF/25 species); reptile diversity can remain high in the face of considerable disturbance of a forest (e.g., Fairbairn Dam remnant *Callitris* forest with 24 small reptile species); and predictably, that agricultural lands are depauperate in terms of reptile diversity. Although *Pogona barbata* (Cuvier, 1829), *Tiliqua scincoides* (White ex Shaw, 1790), *Antaresia maculosus* (Peters, 1873) and *Pseudonaja textilis* (Duméril, Bibron & Duméril, 1854) to remain conspicuous (?common) on and near roads in agricultural areas and fringing strips of forest and weeds, agricultural lands apparently support fewer species than reported previously from these areas prior to clearing (e.g., Slevin, 1955; Covacevich et al., 1996b).

DISCUSSION

Biodiversity has declined in the BB due to clearing of native vegetation. Only 2.07% of the region is set aside expressly for protection of biodiversity; a further 4% is afforded some protection in state lands. Forty percent of the regional ecosystems are known to be at risk, with most Brigalow systems endangered. One reptile species is critically endangered, possibly extinct; 16 are at risk; and 5 are of concern locally. There will be additions to the list of critically endangered-vulnerable species (13) and more species will be recognised as being at risk if the threatening processes responsible for past demises are not modified.

In return for clearing much of the BB there have been many gains.

'... Originally a sheep raising district, the fertile soils now support extensive grain-growing, chiefly wheat but including barley, maize, oats and oilseeds; irrigated land in the west produces cotton. Dairy and beef cattle are also important, and oil, natural gas and coal are natural resources ...' (Dawson, 1990). '... In 1982, (Emerald's) population was about 4,500. Today, Emerald is a boom town. Its wealth is derived from cattle, cotton, oranges, wheat, sorghum, mung beans, sunflower seeds, and coal and gold mines. In the principal catchment area of Emerald, there are now 50,000 people, most of whom must be living well, because the average annual household income in the area is $45,000 ...' (Hay, 1995). Large financial investments are proposed to continue to increase productivity. This will involve further clearing and intensification of land use. In 1995, the Queensland Government '... endorsed a plan to investigate three water infrastructure development projects in the Fitzroy Basin ... pipeline from Eungella Dam to the central Queensland coalfields(;) a proposed dam on the Dawson River to provide urban, industrial and irrigation water ... to existing and new land ... to be developed (; and) ... a proposed dam on the Comet River to provide urban, industrial and irrigation supplies to lands adjacent to the Comet, Nogoa and MacKenzie Rivers ...' (Queensland Department of Primary Industries, undated, ?1995). A recent report of the Queensland Government's

Water Infrastructure Task Force (1997) recommends for the BB, eight Category 1 water supply projects suitable for continuation or commencement of detailed planning and assessment; three for regional planning and assessment studies; two for groundwater projects; and one general proposal for water supply research, catchment management and on-farm water conservation. The Task Force also recognised 'All infrastructure development projects should be subject to satisfactory outcomes of normal impact assessment studies (including environmental, economic, social and cultural impacts) and negotiation of satisfactory funding arrangements prior to recommendation for funding by Government ...'. Further, all Australian state governments have recently (July, 1996) signed 'National Principles for the Provision of Water for Ecosystems' following representations to the Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand. A major goal of these principles is '... providing water for the environment ... to sustain and, where necessary, restore ecological processes and biodiversity of water dependent systems ...'. The construction of dams will lead to increased pressures on the reptiles (and other species) of the BB, through progressive intensification and expansion of agriculture and associated infrastructure. This impact will not only occur in areas directly affected, ie the irrigation areas. The size of this investment will encourage development across the whole region. This, in turn, will threaten remaining significant remnants of native vegetation. By comparison, proposals to address nature conservation in the BB have not yet been accepted as urgent.

IMPORTANCE OF TYPE LOCALITIES. In any area as assailed by clearing as is the BB, type localities, critical in species delineation, become important in the preservation of diversity. This principle applies particularly where species are narrowly confined or virtually-confined to a region as are many of the reptile species of the BB. The type locality is '... the place where the population occurs from which the type specimen [i.e., the specimen on which the description and name of any species are based] was taken ... The "type" affords the standard of reference that determines the application of the scientific name ...': [ ] ours (Rules of Zoological Nomenclature in Mayr, 1969).

Some BB type localities for reptile species have been published (Covacevich, 1996). The complete list of BB type localities for reptile species is extensive (Table 3). Many were poorly-defined in early type descriptions; many are now cities or towns; and some have been cleared for agriculture and/or grazing. Only a few support anything like the vegetation present when the type specimens were collected. Those where good tracts of native (and near native) vegetation remain are highlighted in Table 3.

LESSONS FROM THE BRIGALOW BELT. The BB in Queensland is a fine example of how to diminish diversity — encourage clearing of native forests, through taxation and other incentives; fail to secure in conservation reserves representatives of all vegetation types in the region; recognise late, after several species have become extinct or are in decline, that a major problem in maintaining diversity exists; and proceed with plans for further development even though diversity is already known to be assailed. As attempts progress to improve biodiversity protection in the BB, lessons from other settings become relevant:

1) Research/management attention focussed narrowly on a particular habitat/region or on rare species is, inevitably, costly for other habitats/regions/species (e.g., Voous, 1977; Covacevich & McDonald, 1993).

2) 'We should pay more attention to habitats rather than concentrating heavily or solely on special-interest taxa' (Czechura & Covacevich, 1985).

3) Although habitat protection is the best approach to species protection, it cannot guarantee species survival and habitat destruction guarantees loss of species (e.g., Ingram & McDonald, 1993; Covacevich et al., 1996).

4) '... fauna protection authorities ... have tended to approach reptile conservation by ... restrictions on ... collecting and keeping ... (so) much emphasis has been placed on rare and endangered species, a flawed approach, which allows statutory protection of habitat and mandatory requirements that wildlife authorities monitor populations ...' (Rawlinson, 1981, in Czechura & Covacevich, 1985).

5) Perhaps most important is the finding that '... Species-rich areas ('hot spots') frequently do not coincide for different taxa, and many rare species do not occur in the most species-rich (areas) ...' (Prendergast et al., 1993).

In the Queensland BB it is apparent that small, remnant patches of native vegetation support many reptile species. However, a paucity of data makes it impossible to determine whether or not these areas can sustain reptile populations in the

TABLE 3. Queensland BB type localities for nominate reptile species. Type localities where good tracts of native vegetation remain are highlighted *.

Warrawee Stn, 60km SE 20°24' 146°40'*	*Lerista cinerea* Greer, McDonald & Lawrie, 1983
Mt Cooper Stn, 90km SE 20°31'S 146°47'E	*Lerista vittata* Greer, McDonald & Lawrie, 1983
Bowen (as Port Denison)	*Aspidiotes melancephalus* Krefft, 1864 = *Aspidites melanocephalus* (Krefft, 1864)
Bulliwallah Stn, on Belyando R., via Clermont *	*Varanus bulliwallah* Worrell, 1956 = *Varanus mertensi* Glauert, 1951
Barmount 80km NW Marlborough 22°32' 149°06' MEQ*	*Menetia timlowi* Ingram, 1977
Batheaston Stn 22°26'S 148°47'E*	*Gehyra catenata* Low, 1979
Lake Elphinstone	*Tropidolepisma striolatum* Peters, 1870 = *Egernia striolata* (Peters, 1870) *Hoplocephalus frenatus* Peters, 1870 = *Suta suta* (Peters, 1863)
Retro, Capella	*Rhodona allanae* Longman, 1937 = *Lerista allanae* (Longman, 1937)
Peak Downs	*Diplodactylus steindachneri* Boulenger, 1885 *Nephrurus asper* Günther, 1876 *Delma orientalis* Günther, 1876 = *Paradelma orientalis* (Günther, 1876) *Rhondona fragilis* Günther, 1876 = *Lerista fragilis* (Günther, 1876) *Lygosoma heterodactylum* Günther, 1876 = *Glaphyromorphus punctulatus* (Peters, 1871)
Central Queensland	*Grammatophora inermis* De Vis, 1888 = *Ctenophorus nuchalis* (De Vis, 1884)
neighbourhood of Rockhampton	*Hoplocephalus nigrostriatus* Krefft, 1864 = *Rhinoplocephalus nigrostriatus* (Krefft, 1864) *Hoplocephalus nigrostriatus* Krefft, 1864 = *Rhinoplocephalus nigrostriatus* (Krefft, 1864)
near Rockhampton	*Denisonia ornata* Krefft, 1869 = *Denisonia maculata* (Steindachner, 1867)
Rockhampton	*Heteropus schmeltzii* Peters, 1867 = *Carlia schmeltzii* (Peters, 1867) *Pseudechis scutellatus* Peters, 1867 = *Oxyuranus scutellatus* (Peters, 1867) *Hinulia fasciolata* Günther, 1867 = *Eremiascincus fasciolatus* (Günther, 1867) *Tiliqua longicauda* De Vis, 1888 = *Cyclodomorphus gerrardii* (Gray, 1845) (designated by Wells & Wellington, 1985) *Phyllodactylus anomalus* Peters, 1867 = *Heteronotia binoei* (Peters, 1867) *Pseudechis scutellatus* Peters, 1867 = *Oxyuranus scutellatus* (Peters, 1867) *Typhlops (Onchyclocephalus) unguirostris* part Peters, 1867 = *Ramphotyphlops unguirostris* (Peters, 1867)
restricted to Rockhampton	*Hoplocephalus maculatus* Steindachner, 1867 = *Denisonia maculata* (Steindachner, 1867)
Rockhampton and Peak Downs	*Hoplocephalus damelii* Günther, 1876 = *Hemiaspis damelii* (Günther, 1876)
Rockhampton, 1km E of Frenchville 23°22'S 150°32'E	*Anomalopus brevicollis* Greer & Cogger, 1985
Fitzroy R., 63km N & 22km E of Duaringa, elevation 40m, 23°09'S 149°55'E	*Rheodytes leukops* Legler & Cann, 1980
19km W of Emerald 81.5km E of Bogantungan*	*Oedura attenboroughi* Wells & Wellington, 1985
15 miles S Duaringa	*Glyphodon barnardi* Kinghorn, 1939 = *Furina barnardi* (Kinghorn, 1939)
State Forest, foothills of Mt Larcom 23°49'S 151°22'E*	*Heteropus mundus* De Vis, 1885 = *Carlia munda* (De Vis, 1885)
Gyrandra, Dawson R. (as Upper Dawson R.)	*Lygosoma bancrofti* Longman, 1916 = *Anomalopus leuckartii* (Weinland, 1862)
Port Curtis*	*Simotes australis* Krefft, 1864 = *Smoselaps australis* (Krefft, 1864)
Monto	*Phyllurus salebrosus* Covacevich, 1975 = *Saltuarius salebrosus* (Covacevich, 1975)
Eidsvold, Upper Burnett R.*	*Varanus punctatus orientalis* Fry, 1913 = *Varanus tristis* (Schlegel, 1839)
Burnett River *	*Diemenia maculiceps* Boettger, 1898 = *Demansia vestigiata* (De Vis, 1884) *Lygosoma verreauxii biunguiculata* Oudemans, 1894 = *Anomalopus leuckartii* (Weinland, 1862)
Chinchilla	*Diplodactylus taenicauda* De Vis, 1886 *Egernia whitei modesta* Storr, 1968 = *Egernia modesta* (Storr, 1968)
Chinchilla, Darling Downs	*Heteropus vertebralis* De Vis, 1888 = *Carlia mundivensis* (Broom, 1898)
Mowen (?=Morven) central railway	*Typhlops diversus* Waite, 1894 = *Ramphotyphlops diversus* (Waite, 1894)
Glenmorgan*	*Glyphodon dunmalli* Worrell, 1955 = *Furina dunmalli* (Worrell, 1955) *Denisonia dwyeri* Worrell, 1956 = *Suta dwyeri* (Worrell, 1956)
near Surat	*Hoplocephalus ornatus* De Vis, 1884 = *Denisonia devisi* (Waite & Longman, 1920)
Cecil Plains, SEQ	*Pseudechis guttata* De Vis, 1905
Moombah Stn., *ca* 64km W Westmar, *ca* 60km NE St George, SEQ 27°59'S 149°18'E*	*Ctenotus ingrami* Czechura & Wombey, 1982

long term. Our recent field work in the BB has shown that reptile diversity in some areas, all still supporting native vegetation, is high. However, despite the intensity of this work and success in finding reptiles, few of the 20 species at risk in the BB were encountered. In Dipperu NP, none of these species was found; in Inglewood SF one (*Acanthophis antarcticus*) was found and one (*Paradelma orientalis*) has been found since (Schultz & Eyre, 1997); in *Callitris* forest near

Emerald, one (*Diplodactylus taenicauda*) was common (Deer, 1996); and an isolated population of *Aspidites ramsayi* is well-known in the Yuleba district. These results superficially support the findings of Prendergast et al., 1993, that '... A limited number of species-rich areas do not guarantee effective conservation for rare and restricted organisms, many of which occur outside species-rich areas ...'. However, they are far from a thorough assessment of the question of the coincidence of diversity hotspots and rare species in the BB.

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APPENDIX 1

Reptile species of the Brigalow 'Belt' of Queensland.

Family Chelidae

Chelodina expansa Gray, 1857
C. longicollis (Shaw, 1802)
Elseya dentata (Gray, 1863)
E. irwini Cann, 1997
E. latisternum Gray, 1867
E. mydura krefftii (Gray, 1871)
E. macquarii (Gray, 1831)
Rheodytes leukops Legler & Cann, 1980

Family Gekkonidae

Diplodactylus conspicillatus Lucas & Frost, 1897
D. steindachneri Boulenger, 1885
D. taenicauda De Vis, 1886
D. tessellatus (Günther, 1875)
D. vittatus Gray, 1832
D. williamsi Kluge, 1963
Gehyra catenata Low, 1979
G. dubia (Macleay, 1877)
G. variegata (Duméril, 1836)
Heteronotia binoei Gray, 1845
Nephrurus asper Günther, 1876
N. milii (Bory de St Vincent, 1825)
Oedura castelnaui Thominot, 1889
O. lesueurii (Duméril & Bibron, 1836)
O. marmorata Gray, 1842
O. monilis De Vis, 1888
O. rhombifer Gray, 1845
O. robusta Boulenger, 1885
O. tryoni De Vis, 1885
Rhynchoedura ornata Günther, 1867
Saltuarius salebrosus (Covacevich, 1975)

Family Pygopodidae

Delma inornata Kluge, 1974
D. labialis Shea, 1987
D. plebeia De Vis, 1888
D. tincta De Vis, 1888
Lialis burtonis Gray, 1835
Paradelma orientalis (Günther, 1876)
Pygopus nigriceps Fischer, 1882

Family Scincidae

Anomalopus brevicollis Greer & Cogger, 1985
A. leuckartii (Weinland, 1862)
A. mackayi Greer & Cogger, 1985
A. verreauxii Duméril, 1851
Carlia jarnoldae Covacevich & Ingram, 1975
C. munda (De Vis, 1885)
C. mundivensis (Broom, 1898)
C. pectoralis (De Vis, 1885)
C. schmetzii (Peters, 1867)
C. tetradactyla (O'Shaughnessy, 1879)
C. vivax (De Vis, 1885)
Cryptoblepharus carnabyi (Storr, 1976)
C. plagiocephalus (Cocteau, 1836)
C. virgatus (Garman, 1901)
Ctenotus allotropis Storr, 1981
C. eutaenius Storr ,1981
C. hebetior Storr, 1978
C. ingrami Czechura & Wombey, 1982
C. pantherinus Peters, 1866
C. robustus Storr, 1971
C. strauchii (Boulenger, 1887)
C. taeniolatus (Shaw, 1790)
Cyclodomorphus gerrardii (Gray, 1845)
Egernia cunninghami (Gray, 1832)
E. frerei Günther, 1897
E. modesta Storr, 1968
E. rugosa De Vis, 1888
E. striolata Peters, 1870
Eremiascincus fasciolatus (Günther, 1867)
E. richardsoni (Gray, 1845)
Eulamprus brachysoma (Lönnberg & Andersson, 1915)
E. martini Wells & Wellington, 1985
E. quoyii (Duméril & Bibron, 1839)
E. sokosoma Greer, 1992
E. tenuis Gray, 1831
Glaphyromorphus punctulatus (Peters, 1871)
Lampropholis delicata (De Vis, 1888)
L. mirabilis Ingram and Rawlinson, 1981
Lerista allanae (Longman, 1937)
L. cinerea Greerm McDonald & Lawrie, 1983
L. fragilis (Günther, 1876)
L. muelleri (Fischer, 1881)
L. punctatovittata (Günther,1867)
L. vittata Greer, McDonald & Lawrie, 1983
Lygisaurus foliorum De Vis, 1884
Menetia greyii Gray, 1845
M. sadlieri Greer, 1991
M. timlowi Ingram, 1977
Morethia boulengeri (Ogilby, 1890)
M. taeniopleura (Peters, 1874)
Proablepharus kinghorni (Copland, 1947)
Saiphos equalis (Gray, 1825)
Tiliqua multifasciata Sternfeld, 1919
T. rugosa (Gray, 1827)
T. scincoides (Shaw, 1790)

Family Agamidae

Amphibolurus burnsi (Wells & Wellington, 1985)

A. gilberti (Gray, 1842)
A. muricata (Shaw, 1790)
A. nobbi Witten ,1972
Chlamydosaurus kingii Gray, 1825
Ctenophorus nuchalis (De Vis, 1885)
Diporiphora australis (Steindachner, 1867)
Physignathus lesueurii (Gray, 1831)
Pogona barbata (Cuvier, 1829)
Tympanocryptis lineata Peters, 1863
T. pinguicolla Mitchell, 1948

Family Varanidae

Varanus gouldii (Gray, 1838)
V. mertensi Glauert, 1951
V. panoptes Storr, 1980
V. scalaris Mertens, 1941
V. tristis (Schlegel, 1839)
V. varius (Shaw, 1790)

Family Typhlopidae

*Ramphotyphlops affinis (*Boulenger, 1889)
R. bituberculatus (Peters, 1863)
R. grypus (Waite, 1918)
R. ligatus (Peters, 1879)
R. proximus (Waite, 1893)
R. unguirostris (Peters, 1867)
R. wiedii (Peters, 1867)

Family Boidae

Antaresia maculosa (Peters, 1873)
Aspidites melanocephalus (Krefft, 1864)
A. ramsayi (Macleay, 1882)
Morelia spilota (Lacépède, 1804)

Family Colubridae

Boiga irregularis (Merren, 1802)
Dendrelaphis punctulata (Gray, 1827)
Tropidonophis mairii (Gray, 1841)

Family Elapidae

Acanthophis antarcticus (Shaw, 1794)
Cacophis harriettae Krefft, 1896
Demansia papuensis (Macleay, 1877)
D. psammophis (Schlegel, 1837)
D. torquata (Günther ,1862)
D. vestigiata (De Vis, 1884)
Denisonia devisi Waite & Longman, 1920
D. maculata Steindachner, 1867
Furina barnardi (Kinghorn, 1939)
F. diadema (Schlegel, 1837)
F. dunmalli (Worrell, 1955)
Hemiaspis damelii (Günther, 1876)
Hoplocephalus bitorquatus (Jan, 1859)
Notechis scutatus (Peters, 1861)
Pseudechis australis (Gray, 1842)
P. guttatus De Vis, 1905
P. porphyriacus (Shaw, 1794)
Pseudonaja nuchalis Günther, 1858
P. textilis (Dumeril, Bibron, & Dumeril, 1854)
Rhinoplocephalus boschmai (Brongersma & Knaap-van Meeuwen, 1961)
R. nigrescens (Günther, 1862)
R. nigrostriatus (Krefft, 1864)
Simoselaps australis Krefft, 1864
Suta dwyeri (Worrell, 1956)
S. suta (Peters, 1863)
Vermicella annulata (Gray, 1841)